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ON THE SYSTEMATIC POSITION OF THE GENUS *DISCOSORUS* HALL AND RELATED GENERA

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Bigsby for the first time described specimens of a genus, still unknown to him, which was later called *Discosorus.* When in 1828 he published his paper on the Geology and Geography of Lake Huron,[2] he figured a few problematic fossils which he called "columns composed of circular discs." Bigsby, in his usual extremely careful manner, did not name these fossils, although they are not more difficult to identify than most of the specimens described by him in later publications.

In 1852, Hall[3] described a specimen of the same kind from the Silurian of the State of New York and named it *Discosorus,* with *Discosorus conoideus* as the only species. Unfortunately, one year earlier Hall had described another species from Michigan under the same specific name.[4] In view of the fact that Hall apparently in his manuscripts described the Michigan species first and the publication of his paper was delayed involuntarily, Foerste in 1924[5] designated the New York specimen as the true *Discosorus conoideus* and therefore as the type of the genus, whereas he gave the name *Discosorus halli* to the Michigan specimen. This opinion of Foerste does not seem to be in accordance with the International Rules of Nomenclature. The specific name *conoideus* has to be maintained for the species first described under this name, and the New York specimen will have to be renamed.

Hall, in describing the genus, did not place it in the systematic order, and refused to give it any distinct place. He says (p. 99): "I propose this name for a peculiar fossil body whose relations are at present unknown to me."

Thus the question as to where to place the genus *Discosorus* was undecided when Barrande in 1866 took up the problem. He discusses the characters of *Discosorus* in several places in his monograph on the

[1]Geologisch-paläontol. Institut, Technische Hochschule, Berlin, Germany.
[2]1828, 'Trans. Geol. Soc. London,' I.
[3]1852, 'Pal. of New York,' II.
[4]1851, Foster and Whitney's Rept., p. 222.
[5]1924, 'Silurian Cephalopods of Northern Michigan,' Contributions from the Mus. of Geol., Univ. of Mich., II, No. 3.

cephalopods of Bohemia, and nearly every time he touches upon the question he has another view of it.

In 1866, Barrande[1] reproduced two of the figures given by Bigsby, but with the apical end down. He regards the "columns" as siphuncles of cephalopods for the first time, thus putting *Discosorus* into this group. He points out a possible relationship between *Discosorus* and forms like *Orthoceras docens*, the siphuncle of which decreases in diameter very rapidly towards the living-chamber. In the same way he explains the *Discosorus* specimens as siphuncles, the segments of which are very wide at the base of the phragmocone and extremely narrow at the top.

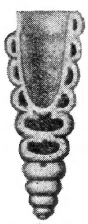


Fig. 1. *Endodiscosorus* sp. from Drummond Island.
(Reproduced from Barrande, 1877, Pl. 474, figs. 9–10. See also Foerste, 1924, Pl. IX, fig. 2.)

In 1870 Barrande[2] had changed his mind and figured a specimen which he called *Orthoceras (Discosorus) conoideus*, from the shore of Lake Timiskaming in Canada, with the apical end down. He was later convinced that this siphuncle belonged to the group with segments increasing in diameter towards the living-chamber and beginning with very narrow segments at the base. However, very carefully he states that he believes he recognizes obstruction rings in the arrangement of the endosiphuncular deposits.

Again in 1871[3] he figured two specimens of *Discosorus*, the one published as Figs. 9 and 10 being the more interesting of the two. This is a rather small specimen, here reproduced as Fig. 1, with a clearly visible endocone. There is nothing like obstruction rings in the interior of the siphuncle. The endocone has smooth walls and increases in diameter continually towards the top of the specimen. Barrande, however, does not discuss the characteristics of this specimen in this place.

In 1874[4] he devoted a whole chapter to the *Discosorus* question. He recognized that several different types are to be found among the specimens placed in this genus, but he was then entirely uncertain about its systematic position. He even tended to doubt whether it belonged to the cephalopods at all. Thus he writes (p. 752): "En somme, malgré les apparences extérieures semblables ou très analogues, que présentent les divers fossiles que nous venons de passer en revue, il ne serait pas rational d'admettre en ce moment, qu'ils sont de même nature générique.

[1]Système Silurien du Centre de la Bohême.' 1ière Pt., II, Céphalopodes. Pl. 232, Figs. 1–2.
[2]Ibid., Pl. 437, Figs. 19–20.
[3]Ibid., Pl. 474, Figs. 7–10.
[4]Ibid. Texte, Part III, pp. 750–752.

On peut aussi douter, qu'ils appartiennent tous, ou même en partie, à la classe de Céphalopodes."

Whitfield in 1882[1] described a specimen of *Discosorus conoideus* with partly preserved septa which cleared up the affinities of the genus. Nevertheless *Discosorus* does not appear in the lists of cephalopods given by Hyatt in 1884[2]. Foord, however, in 1888[3] described two new species of *Discosorus*. Moreover, he for the first time connected it with the Actinoceratidæ. He also observed a number of very characteristic facts pertaining to the endosiphuncular structure of this genus. He pointed out that "a large funnel-shaped sheath, recalling the similar structures of *Piloceras*, forms a conical chamber, which occupies the upper or more expanded part of the siphuncle. This sheath, doubtless originally membranous, has a sinuous outline, due to the concavities of the siphuncular segments. . . . The whole of the apical portion of the siphuncle as well as the space around the sheath, is infiltrated with calcareous matter, the cavity of the sheath being filled with matrix. . . . An endosiphon is present, but it is not very well preserved in any of the specimens I have examined." The longitudinal section of a specimen of *Discosorus conoideus*, figured by Foord as Fig. 25B, page 194, refigured here as Fig. 2, gives a very good idea of the general characters of the siphuncular structure of this genus. A rather large endocone in the upper half of the section continues into a small and narrow endosiphuncular tube in the lower part. There is also calcareous matter in the space left between the endocone and the endosiphuncular tube and the outer wall of the siphuncle. Furthermore, there is that very characteristic bump at the bottom of the endocone which is so significant for all the species of the genus *Discosorus*. Foord, however, failed to point out clearly what the affinities of this genus are to the other members of the Actinoceratidæ, and how it is justifiable to place with this family a genus the endosiphuncular structure of which he himself compares with that of the endoceroid genus *Piloceras*.

Apparently following the opinion of Foord, Hyatt in 1900[4] enumerated *Discosorus* among the Actinoceratidæ without discussing it in any detail.

Not until 1924 do we again meet with the genus *Discosorus* in the literature, when Foerste described and figured numerous species, among them several new ones. At the same time he split up what was formerly

[1]Geol. Surv. Wisconsin, IV, 3. 'Paleontology,' Pl. XX, Fig. 6.
[2]1884, 'Genera of Fossil Cephalopods,' Boston Soc. Nat. Hist., XXII.
[3]1888, 'Catalogue of the Fossil Cephalopoda of the British Museum,' I, p. 194.
[4]Zittel-Eastman, 'Textbook of Palæontology,' Cephalopods

called *Discosorus* into two genera, leaving with *Discosorus* the shorter and more rapidly tapering forms, and putting the longer and more slender forms into the new genus *Stokesoceras*. He refigured and redescribed a number of the older type specimens of Hall and Foord. For the first time we here find together good pictures and descriptions of the several kinds of structures which we may encounter in the siphuncles of *Discosorus* and allied genera. Foerste's figure of *Stokesoceras gracile* (Pl. VIII, fig. 3A and B) reveals a typical section of the long and slender *Stokesoceras* type with its rather long and slowly tapering endocone

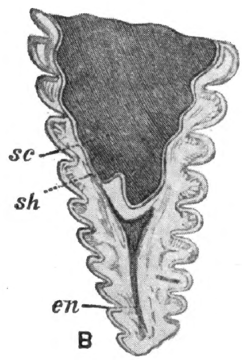


Fig. 2

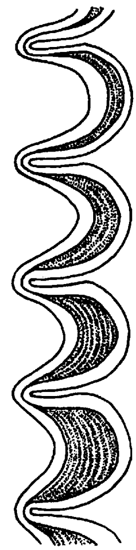


Fig. 3

Fig. 2. *Discosorus ehlersi* Foerste. From Drummond Island.
(Reproduced from A. H. Foord, 1888, p. 194.)

Fig. 3. Diagrammatic sketch of the organic deposits within the siphuncle of *Discosorus*.
(From the specimen shown on figure 5.)

with the walls of the endocone but slightly annulated. Another type is represented by Fig. 2 on Pl. VII, where the walls of the endocone are decidedly annulated. This specimen, which is named *Stokesoceras engadinense*, shows very clearly the passing of the endocone into the endosiphuncular tube. The latter has a very peculiar intermittent growth which so far has not been observed in any other specimen. A third type, represented by a specimen named *Stokesoceras romingeri*, on Pl. IX, fig. 2, will be discussed later.

One of the specimens figured by Foerste (Pl. VII, fig. 5) as *Discosorus ehlersi* certainly does not belong to this genus or to this group. There is a calcareous lining along the walls of the segments of the siphuncle, but this does not increase in thickness towards the apical end, and no real endocone is visible.

In 1925, Foerste again[1] figured some of the specimens discussed in his previous paper. In addition, he established a few new ones and also described a new genus, *Megadiscosorus*, which he apparently regarded as closely related to *Discosorus*. Three species provisionally put into *Discosorus*, namely, *D.* (?) *vetustus, D.* (?) *geronticus*, and *D.* (?) *earltonensis*, certainly belong to *Armenoceras* rather than to *Discosorus*.

In 1927, Foerste and Savage[2] described a few new species of *Discosorus*.

The affinities and relationship of the genera *Discosorus* and *Stokesoceras*, and also *Megadiscosorus*, have not been discussed in any of these papers. However, valuable material has been brought together, which enables us, in connection with some other so far unpublished facts, to get a much better, though not yet complete, idea of the structure of this peculiar siphuncular body than would have been possible a few years ago.

When Foerste and Teichert in 1930[3] compiled the list of the known families and genera of the actinoceroids, they included *Discosorus* and *Stokesoceras* in this list and connected those two genera with the Armenoceratidæ as had been done by Troedsson in 1926.[4] However, the classification of *Discosorus* and *Stokesoceras* was attempted in this case with regard to the external shape of the siphuncles only, and without paying attention to the endosiphuncular structures and the remarkable and fundamental differences existing in this respect between those two genera on the one hand and the typical actinoceroids on the other.

It will be the purpose of the following pages to show that *Discosorus* and related genera belong neither to the Armenoceratidæ nor to the actinoceroids, but form a family themselves, though still of uncertain and doubtful affinities.

In the first place, I here shall take into consideration the characters of what is known to be the true *Discosorus* as defined by Foerste. A very characteristic longitudinal section of a true *Discosorus* has been figured by Foord (1888, p. 194) as *Discosorus conoideus*. A specimen with similar characters is in the collection of the National Museum in Ottawa and is

[1]1925, Foerste, in G. S. Hume, Paleozoic Outlier of Lake Timiskaming. Canada Geol. Surv., Mem. 145.
[2]1927, Denison Univ. Bull., Journ. Sci. Lab., 22.
[3]1930, Ibid., 25.
[4]1926, Meddelelser om Grønland. 71.

shown here as Fig. 5. Though in this case the species cannot be identified with certainty, and the locality and horizon are unknown, the specimen undoubtedly belongs to the genus *Discosorus*. There is a very significant calcite lining on the inner side of the segmental walls which is thin in the upper segments and gradually increases in thickness from one segment to another in an apical direction. On the right side of the specimen, the inner side of this calcite layer is very concave in the upper four segments, but less concave in the fourth than in the first. It becomes still less concave in the next two segments, and the concavity has about disappeared along the inner side of the layer in the seventh and eighth segments. On the left side of the specimen, we see practically the same conditions, with the exception that the calcite layer is thinner on this side. It is absolutely sure that this calcite layer is of primary organic origin; otherwise it could not be explained why it increases so regularly and continually from one segment to the other. It is remarkable that the layer tends to fill out the outer parts of the segments only, whereas it remains of about equal thickness around the septal foramina along those places where septa or septal necks are supposed to have constricted the siphuncle.

The calcite filling of the exterior parts of the segments consists of three different layers. The outer layer continues along the walls of the segments, slightly increasing in thickness in the middle portion of each of the latter and decreasing when passing the septal foramina. Secondly, there is an inner layer which is in contact with the outer layer in the passage through the septal foramen, but free from contact for nearly the

Fig. 4. *Stokesoceras* cf. *engadinense* Foerste. Cockburn Island, Lake Huron. Niagaran Group.

No. 2743 in the National Museum in Ottawa. Magnified 1.6 diameters.

Fig. 5. *Discosorus* sp. Unknown locality and horizon in Canada.

No. 6367 in the National Museum in Ottawa.

Fig. 6. *Discosorus conoideus* Hall. Cockburn Island, Lake Huron. Niagaran Group.

No. 2743*c* in the National Museum in Ottawa. View into the endocone. Natural size.

Fig. 7. *Discosorus conoideus* Hall. Cockburn Island, Lake Huron. Niagaran Group.

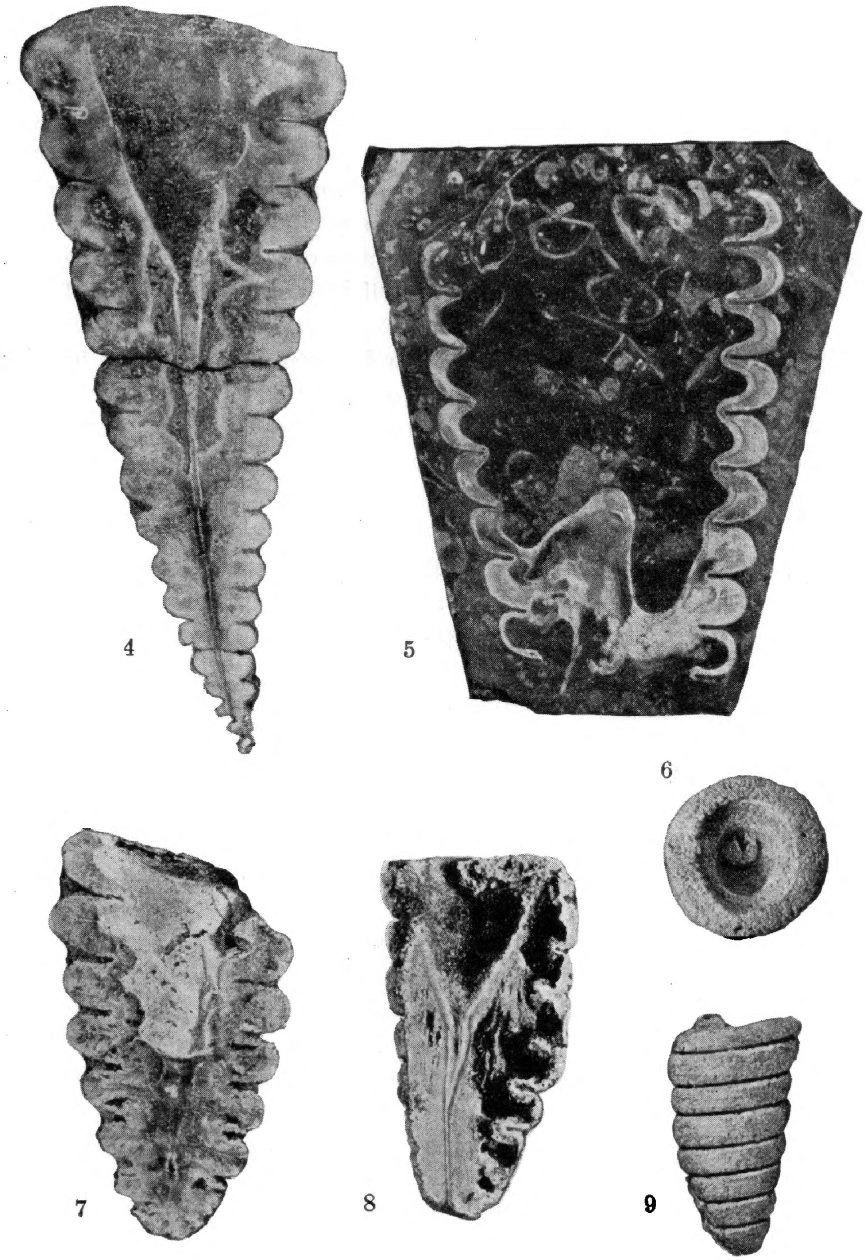
No. 2743*b* in the National Museum in Ottawa. Magnified 1.6 diameters.

Fig. 8. *Endodiscosorus foerstei*, new genus and species. From the Niagaran of Lake Timiskaming.

In the private collection of the present writer. Holotype. Longitudinal section, magnified 1.6 diameters.

Fig. 9. Same as Fig. 8..

View from the opposite side, natural size.



Figs. 4-9
(Captions on opposite page)

entire height of the segments. This layer has a constant thickness. Between the septal foramina, a third layer has been deposited between the inner and the outer layer. Apparently this third layer is the real organic deposit which is increasing continually. This layer in most of the segments has a lunette-shaped cross-section and doubtless was deposited by a membrane which may now be represented by the inner layer. Figure 3 may serve to illustrate the characters of these different deposits.

These three layers can be distinguished, roughly, in the figure given by Foord of what he called *Discosorus conoideus* (Fig. 2). It also can be seen that the middle layer grew in such a way that it lost its lunette-shaped cross-section very soon and that the layers of two adjacent segments came in contact. The lower part of the specimen is filled by a deposit which is a continuation of the middle layer, and only a narrow endosiphuncular tube is left open.

A remarkable feature of the endocone is an elevation or bump on its bottom. In true *Discosorus* the endocone seldom has a really conical shape. It always ends rather abruptly at a level where the endocone is still wide, and its bottom is made up by the same calcareous layer which builds the sides of the endocone. The bottom of the endocone never is evenly concave, but there is always a larger or smaller elevated area. This is elucidated not only by the specimen shown on figure 2, and figure 5, but is also very well illustrated by a smaller specimen shown in figure 6. It follows from the study of the latter specimen that the endosiphuncular tube originated in the center of this bump. The bump itself is not situated exactly in the central axis of the endocone, but is nearer the convex side of the specimen.

The deposits within the interior of the siphuncle of *Discosorus* never have the appearance of true "obstruction rings" as in the actinoceroids. There are no radial canals left to connect the endocone or the endosiphuncular tube with the walls of the segments or with the perispatium,[1] the free space between the obstruction deposits and the walls of the segments. In some specimens, something like a line of partition can be observed in the mid-height of the segments, dividing the deposits around one septal neck from the deposits around the septal neck below, as can be observed in a specimen of *Discosorus conoideus* (Fig. 7). However, no real canals have been observed in the level of this line of partition, and it may be assumed that this appearance is due to some process of

[1]In his book "Der Bau der Actinoceraten" (in press), the present writer was able to reveal that the obstruction deposits in the interior of the siphuncle never come in contact with the walls of the segments. The free space between the obstruction rings and the walls of the segments has been called "perispatium."

recrystallization within the organic deposit after the deposition of the specimen in the sediment. It is remarkable that this line of partition never has been found in the upper segments, where the deposits are still small, but in the lower segments only. But even if the partition line were of primary origin in some specimens or species, its origin must be of a quite different type from that in the true actinoceroids.

Briefly, we may characterize the endosiphuncular structure of *Discosorus* as follows:

Deposits along the walls of the segments, increasing gradually towards the apical end, leaving free a rather wide endocone in the upper half of the siphuncle, but only a very small endosiphuncular tube in the lower part. Except the space left for the endosiphuncular tube, the lower part of the siphuncle is filled with organic deposits. No perispatium is left in the peripheric parts of the segments, and no connections between the endocone or the endosiphuncular tube and the peripheric parts of the segments exist.

Another related character is represented by the genus *Stokesoceras* Foerste. As described by Foerste,[1] "*Stokesoceras* is intended to include those species which resemble *Discosorus romingeri* Foerste in being longiconic and relatively straight." Foerste regarded the external features of the siphuncle only, but there is also a difference in the endosiphuncular structure between this genus and true *Discosorus*. As can be judged from a specimen figured by Foord (1888, p. 26B) as *Discosorus gracilis* and refigured as *Stokesoceras* by Foerste (1924, Pl. VIII, fig. 3A, B), the endocone of this genus is longer than in *Discosorus*. Moreover, the endocone is more or less really conical and does not end abruptly as in *Discosorus*, but decreases gradually in diameter until the top passes into the endosiphuncular tube. The wall of the endocone is almost smooth, though sometimes very slightly convex between the septal foramina and slightly concave when passing through the latter.

The same conditions may be studied in the specimen of *Stokesoceras* cf. *engadinense*: figure 4 of the present paper. The organic deposit along the walls of the segments increases in such a way that a rather regular endocone results, edging out gradually and passing into the endosiphuncular tube which in this case is rather long. It can be traced until near to the last segment. It can also be seen from this specimen that in *Stokesoceras* the siphuncle begins with a very small segment, which is much smaller than any of the first segments known in true actinoceroids. In the latter the siphuncle begins with a rather large seg-

[1]Silur. Ceph. of Mich., *loc. cit.*, pp. 76–77.

ment, and never do the segments increase in diameter so regularly toward the top as they do in *Discosorus* and *Stokesoceras*.

As in *Discosorus*, in *Stokesoceras* we never observe a perispatium.

Besides those two genera, a third genus belongs to this group, which differs from the other genera in some important features:

Endodiscosorus, new genus

Under this name I shall describe a genus which is represented among others by the specimen figured by Barrande in 1870 on Pl. 474, figs. 9 and 10, of his work on cephalopods, and refigured by Foerste in 1924 on Pl. IX, fig. 2. All the specimens of this genus are very short and are characterized by an endocone of entirely regular shape with smooth walls, always continuing into a clearly developed endosiphuncular tube. Furthermore, the walls of the segments of the specimens of this genus are not evenly rounded at their periphery, as in *Discosorus* and *Stokesoceras*, but tend to turn in a nearly right angle from the horizontal to the vertical and again from the vertical to the horizontal direction. Whereas the segments of *Discosorus* and *Stokesoceras* are flat ellipsoids, the segments of **Endodiscosorus** are flat cylinders.

The name **Endodiscosorus** is proposed in order to point out some affinities in the internal structure of the siphuncle between this genus and the endoceroids. This does not mean that in my opinion *Endodiscosorus* really is related to the endoceroids.

The genotype is **Endodiscosorus foerstei.**

Endodiscosorus foerstei, new species

Figs. 8, 9

Length of the entire specimen, 30 mm. Dorsoventral diameter 21 mm. at the top and 17 mm. at the base of the specimen. Average height of the segments, 3.5 to 4 mm. The endocone is regularly conical and thins out gradually into an endosiphuncular tube. Both endocone and endosiphuncular tube are situated eccentrically. The segments run obliquely to the vertical axis of the siphuncle. In the space between the wall of the endocone and the walls of the segments, some dolomitic material is preserved, which seems to have been deposited as vertical lamellæ, thus reminding one of the endosiphuncular sheaths of *Endoceras*. However, it is not at all sure that the lamellæ are the primary form of these deposits and not a result of later recrystallization as can be observed occasionally in the siphuncles of actinoceroids. In any event, the shape of the endocone and of the endosiphuncular tube in this specimen of *Endodiscosorus foerstei* is exactly the same as in specimens of *Endoceras*.

The holotype is from some unknown locality near Lake Timiskaming of the Niagaran group, and is in the private collection of the present writer.

Discosorus, Stokesoceras and *Endodiscosorus* form a family which I propose to call **Discosoridæ.** The Discosoridæ are not related to the actinoceroids. The presence of a clearly developed endocone and an endosiphuncular tube would rather connect them with the endoceroids; but, since endoceroids usually are holochoanitic and have straight and unconstricted or but very little constricted siphuncles, it seems unlikely that the Discosoridæ are related to them. On the other hand, nothing about the structure of the septal neck is known in any of the genera of the Discosoridæ. We do not know anything even about the shape and size of the shell of these fossil animals. Without doubt the Discosoridæ belong to the cephalopods; otherwise the presence of an endosiphuncular tube could not be explained. It is, however, impossible to decide to what order of the cephalopods the family Discosoridæ may belong.

It may be added that the genus *Megadiscosorus* Foerste is a true actinoceroid and, therefore, is not discussed on the previous pages.

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